New Zealand Research and Experimental Development Statistics

All Sectors

1991/92

Ministry of Research, Science and Technology

Te Manatu Putaiao

Publication No. 12

Cover: Significant areas of R&D (Clockwise)

1. Government sector: Research to enhance the productivity of mussel farms; the FRV "Kaharoa" working in Mills Bay, Kenepuru Sound, Marlborough Sounds.

2. Business enterprise sector: High speed motor winding in the production of the Smart Motor for automatic washing machines at Fisher and Paykel.

3. University research: "Examining the sample"; an often essential part of health research even in this age of technological innovation.

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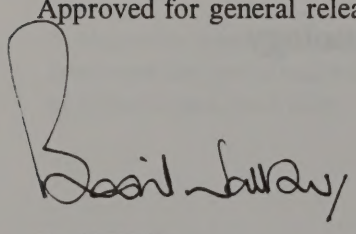
This document is the report of the joint survey of private sector R&D carried out by the Ministry of Research, Science and Technology and Statistics New Zealand.

Approved for general release



Basil Walker
Chief Executive

FOREWORD

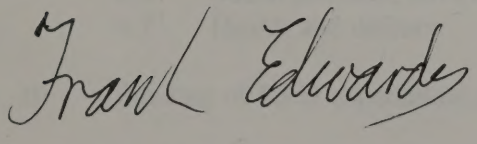
This survey of research and development in the business enterprise sector is the third of a series of R&D surveys to be undertaken by the Ministry of Research, Science and Technology. It was carried out jointly with the Economic and Business Surveys Division of Statistics New Zealand, in Auckland, and should provide valuable information to policy makers in government and business.

The process for carrying out this survey was developed with the valuable assistance of an advisory group whose members were drawn from key sectors of the science and science user communities. I would like to thank the advisory group for their informed comment and attention to detail which have helped to ensure the acceptance of and good response to the survey.

The business community were generally very willing to provide the information and to participate in the survey. I would like to thank Guy Sanders at the Statistics New Zealand who managed, in close consultation with this Ministry, the queries which a technical and complex survey of this nature could be expected to generate. Queries from government agencies were managed by this Ministry.

The tabulations presented here are designed to make information available as quickly as possible. Further analysis of the information especially in relation to economic indicators will be made available in separate reports.

The value of information on R&D increases the longer the time frame over which it is available. This survey will therefore be repeated annually, with the next questionnaire due for dissemination from August 1994.



Frank Edwards
Manager, Information Services
Ministry of Research, Science and Technology

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This report documents results of the third annual survey of Research and Development (R&D) undertaken in New Zealand. Like last year, it provides data on research in the higher education sector as well as for business and government sectors.

One of the functions of the survey is to fulfil New Zealand's international obligations for the collection of R&D statistics. It is also intended that this ongoing survey will provide baseline data of use in science policy making and in assisting both the government and business sectors to make wise R&D investment decisions. Questionnaires were sent out to 2232 enterprises, 53 within government, 2179 in business. The effective response rate was 92.2 percent.

It is estimated that the business sector spent $227 million on R&D (including $19 million spent overseas). The government sector spent $333 million, and universities spent $90 million. Overseas funds for R&D carried out in New Zealand came to $10 million. New Zealand carried out a total $641 million R&D, and funded a further $19 million carried out overseas.

New Zealand's ratio of gross domestic R&D expenditure to GDP was 0.90 percent using GDP at March 1992 of $72,213 million. This compares with the latest figure of 1.65 percent for OECD reference countries. Private sector R&D was 0.30 percent of GDP (1.1 percent for the OECD reference countries), or 34 percent of the total (52 percent for OECD reference countries). Government sector R&D was 0.45 percent of GDP (0.3 percent for the OECD reference countries), or 66 percent of the total (41 percent for OECD reference countries). University sector R&D was 0.15 percent of GDP (or 14% of the total), compared with 0.40 percent for OECD reference countries.

The overall breakdown of how R&D money was spent is very similar to last year: wages and salary 50 percent; current expenditure 39 percent; and capital expenditure 11 percent. Business, however, spent 13 percent of its R&D money on capital items; government spent 9 percent. Research expenditure on Social Development and Services, and Defence, is low by OECD standards, both in the government and business sectors.

New Zealand continues to have a high proportion of government-funded R&D expenditure (64 percent for 1991/92). Government R&D expenditure was concentrated in a few areas, especially Primary Production (50 percent) and the Environment and Natural Resources (23 percent).

Business R&D expenditure was concentrated in: Primary Products and Processing (35 percent); Materials, Engineering and Telecommunications (27 percent); and Infrastructure and Services (20 percent). The two most significant areas are aimed towards improving the performance of our secondary industries which contrasts with the primary-production focus of government R&D. New data is presented that seems to show that small firms have a more important role in the funding of R&D than was hitherto realised.

Total full-time equivalent personnel engaged in research, in all sectors, numbered 8836: 44 percent in government, 26 percent in universities, 22 percent in business, and 8 percent in research associations and producer boards. Women make up 27 percent of the science workforce (excluding universities). They make up 15 percent of researchers, 32 percent of technicians, and 50 percent of support staff.

When university researchers are included, New Zealand has 3.0 FTE research scientists and engineers per 1000 in the labour force, compared with an average of 5.1 per 1000 labour force in OECD reference countries. The national total of R&D personnel represents 5.4 per 1000 of the labour force, compared with 9.3 per 1000 for the OECD reference countries.

INTRODUCTION

1 Background

Previous publications[1,2], which will be referred to throughout this report as the "Business Enterprise Survey" and the "Government Survey", provided the first year of comprehensive statistical data on private and government sector research and development (R&D) in New Zealand. This latest publication extends the survey to its third year, and includes both government and private sectors. There is also some additional data on research in the higher education sector which have been obtained from a benchmark survey[3] of all Crown-funded research, and from further data based on a recalibration of this survey by a joint university and government review of university public good science outputs. This review was carried out during March to June 1992 under the chairmanship of Dr A.E.Bollard[4].

The R&D surveys aim to collect comprehensive R&D statistics from the three sectors so that they can be combined to generate a full picture of R&D. They also aim to establish a methodology for the survey process, which will then be repeated at regular intervals to obtain statistics for release to government, business and other users in the community. The statistics are used in the development of science policy in areas such as the setting of research priorities, government funding levels, research strategies, science education, and innovation encouragement schemes. It is hoped that the statistics will also help decision makers to make R&D investment decisions.

The surveys are being carried out according to international definitions and conform to standards of the Organisation for Economic Cooperation and Development (OECD) for the collection of R&D statistics. The results are used to fulfil New Zealand's international obligations to provide R&D statistics.

Only research and development activities, as defined by the OECD, are included in the survey. Consulting and scientific and technological (S&T) services are excluded.

In line with OECD methodology, statistical information is gathered from the providers rather than the funders of research. This is in order to prevent the same research being reported twice, by both the provider and the funder. Providers are also usually in the best position to determine whether work is R&D or S&T services, and to report on the resources actually expended on research. Information on the sources of the funds used by providers is used to estimate the funding of R&D by each sector.

2 Changes in government-funded research

The past seven or eight years has been a time of considerable change in the nature of government-funded research in New Zealand. The processes which had occurred up to, and including, the time of this survey (December 1992) included:

- Definition of the concept of "public-good" scientific research and of desirable science outcomes resulting from such research;

- Definition of a set of forty science "output classes" and a grouping of these into 24 science areas, used in developing science priorities and funding levels;

- Formulation of all research within each output class in terms of research programmes with stated goals; each programme comprising defined, usually one year, research tasks or objectives;

- The Department of Scientific and Industrial Research, research branches of the Ministry of Agriculture and Fisheries, and the Ministry of Forestry and the Meteorological Service, were re-organised into ten Crown Research Institutes from 1 July 1992; and

- Continuing encouragement for government research organisations to undertake commercial work funded from non-government sources.

New arrangements for the management of public good science were established on 1 October 1989. Science policy advice was separated from the allocation of funding and from science provision with the formation of the Ministry of Research, Science and Technology to advise the Minister of Research, Science and Technology and the Foundation for Research, Science and Technology to allocate funding on a contestable basis. This replaced the direct allocation of funds by Parliament to science departments.

The period of the first R&D survey, 1989/90, was the last year in which the government science departments received their Crown funding through direct appropriation. The contestable bidding system commenced early in 1990 and came partially into effect during the financial year 1990/91 and fully into effect in the current survey year, 1991/92.

3 Role of the Ministry of Research, Science and Technology

When it was established, the Ministry of Research, Science and Technology had the following principal functions:

- To advise the Minister of Research, Science and Technology on national science and technology policy;

- To identify national priorities for government funding of research and technology;

- To facilitate and publish science reviews, to collect data on all forms of national R&D activity, and to fulfil international obligations to provide data on R&D; and

- To maintain international government to government science agreements and to encourage scientific co-operation.

In relation to this survey, the function of the Ministry of Research, Science and Technology is to arrange for the collection of data on national inputs into, and outputs from, R&D, including fulfilling international obligations to provide data on national science and technology activity to the OECD and other bodies.

4 Survey methodology

The survey of government and business enterprise R&D was conducted jointly with Statistics New Zealand.

An advisory group with representatives from the business enterprise sector was set up to review the questionnaire and to advise on the survey methodology. The membership is detailed in Annex 1 to this report. The questionnaire used was the result of the discussion and recommendations made at the advisory group meeting.

Questionnaires and covering information were posted to survey respondents in December and followed up by reminder notices to non-respondents in the new year. This was followed by telephone calls with the objective of achieving a 100 percent response from all government agencies and business enterprises employing more than 100 full-time equivalents.

The final sample population of 2232 enterprises, of which 2179 were business enterprises and 53 government agencies (government departments, statutory authorities and the area health boards), comprised:

- all those who answered "Yes" to a question in Statistics New Zealand's 1991 Annual Business Directory Update survey which asked if they undertook R&D;
- those who answered "Yes" to any of the questions in the 1990/91 R&D survey;
- all large enterprises involved in manufacturing, "large" being defined as those enterprises with more than 100 full-time equivalent persons engaged;
- respondents were also added to the survey when replies to the question "if you paid another organisation(s) to undertake R&D on your behalf, please list the organisation(s) below" identified research performers not already included in the survey; and
- those government departments and Crown agencies undertaking public good research, or operational research to support their own outputs, including positive respondents to the 1990 government sector R&D survey[2].

Twenty three enterprises were deleted from the survey (in the main because the enterprise had ceased trading for the survey reference period). Data was obtained for 2037 respondents: 172 responses were imputed, giving an effective response rate of 92.2 percent.

Non-response questionnaires are imputed by size and industry group cells using full-time equivalents employed as size indicator, cell response rate and the unit data of returned questionnaires within each cell.

Estimation cells group enterprises and government agencies into 40 industry groups. These groups are defined by standard industrial classification.

The data estimated for the non-respondents amounted to one percent of the total R&D expenditure.

5 Definitions used in the survey

This report follows the convention used in OECD publications of standard abbreviations for the measures of R&D. Most of the tables represent expenditure on R&D *carried out* in each of the three sectors: business enterprise R&D or "BERD", government R&D or "GOVERD", and higher education R&D or "HERD". That part of University funds for research which comes from Vote: Education and is part of the employment contract of academic staff is called "general university

funds" or "GUF", as distinct from research monies allocated by independent funding bodies such as the Foundation for Research, Science and Technology or the Health Research Council.

Total *funding* of R&D by each sector is estimated by subtracting from intramural R&D that part which is funded from outside the sector and adding any R&D which it funded in any other sector. Data from R&D providers are preferred because estimates given by funders may include double-counting as the same funds may be provided by one body, allocated by another, and reported by both.

The survey used the OECD definition of R&D: "Research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."

Any activity classified as R&D is characterised by *originality;* it should have *investigation* as a primary objective, the outcome of which is *new knowledge*, with or without a specific practical application, or *new or improved* materials, products, devices, processes or services. R&D ends when work is no longer primarily investigative.

The definition of R&D, in accordance with a change in OECD standards, now includes research into, and development (or substantial modification) of, computer software such as applications software, new programming languages and new operating systems.

A more comprehensive interpretation of the definition of R&D activity is given in the OECD publication *The Measurement of Scientific and Technical Activities* (the Frascati Manual)[6].

Intramural R&D statistics presented in this publication refer to R&D activity *carried out* by an organisation on its *own* behalf or on behalf of other organisations or individuals. *Extramural* R&D statistics refer to R&D activity *funded* by an organisation but *carried out* by others.

R&D *expenditure* includes: *capital* expenditure on the acquisition of fixed, tangible assets such as land, buildings, vehicles, plant, machinery and equipment attributable to R&D activity; *current* expenditure on wages, salaries and other labour costs, materials, repair, travel, etc; and the proportion of expenditure on general services and overheads which is attributable to R&D activity.

Human resources devoted to R&D measures the effort of researchers, technicians and other staff *directly* involved with R&D activity. Overhead staff (e.g. administrative and general services employees such as personnel officers and cleaners) whose work *indirectly* supports R&D activity, are excluded from counts of personnel but their costs are included in overheads.

Researchers are those involved with the conception and/or development of new products or processes. They include project managers, directors, scientists and engineers concerned with project content but exclude those concerned with administrative matters.

Technicians are those performing technical tasks in support of R&D activity, normally under the direction and supervision of a researcher. These tasks include performing experiments, maintaining and operating advanced equipment, and computer programming.

Other supporting staff are those skilled and unskilled craftspersons, and secretarial, administrative and clerical staff directly associated with R&D activity.

Technological balance of payments is the collation of those invisible international transactions relating to trade in technical knowledge or know-how. *Technical know-how* is defined as: existing specialised technical knowledge that is required to produce a successful product or implement a process, e.g. patents; licenses; technical data and information; and scientific, technical or engineering assistance that increases technical knowledge and understanding in the organisation.

Payments for technical know-how exclude other costs such as overseas travel and subscriptions to periodicals as well as the cost of computer software and scientific, technical or engineering services that are not aimed at increasing the technical knowledge of the organisation.

Receipts for technical know-how exclude contract or commission work carried out on behalf of others.

The *business enterprise* sector includes all enterprises whose primary activity is the production of goods or services for sale to the general public at a price intended to cover at least the cost of production, and the private non-profit institutions mainly serving them.

The organisational unit for the collection of R&D statistics is the enterprise. An *enterprise* is defined broadly as the unit comprising all the operations in New Zealand of a single operating legal entity (e.g. company, partnership or sole proprietor).

The vast majority of enterprises included are private businesses. The remainder are public business enterprises mainly engaged in trading or financial activities, research associations funded by levy or grant, producer boards, private non-profit organisations and local authorities.

The survey covered a wide range of industries from NZSIC 11214 *Landscape Planting and Maintenance Services* to NZSIC 95991 *Funeral Directors*, and between all divisions from *Forestry and Logging* to *Personal and Household Services*. The survey covered industries with a total population of 153,996 separate government and private sector enterprises (virtually the entire economy, excluding Agriculture).

Farming enterprises (i.e. industries in major group 111 of the *New Zealand Standard Industrial Classification (NZSIC)*, 1987 edition) were not included in the Statistics New Zealand Business Directory update, so were not canvassed for inclusion in the survey. Farming companies known to be doing R&D were included. Agricultural R&D activity is generally carried out by specialised research associations. The agriculture survey carried out by Statistics New Zealand in June 1993 included a question on R&D, in order to identify farmers who engage in research.

For the purposes of R&D statistics, the OECD recommends that research institutes be classified according to the industry they predominantly serve, and this recommendation has been followed in this report. The predominant output area specified by each research association was used as a guide, and supplementary NZSIC codes assigned and used in all tables for the data provided by the research institute.

Each enterprise is classified to the industry in which it mainly operates even though one or more of its component activity units (factories, shops, etc.) may be classified to other industries. For further comment see the *New Zealand Standard Industrial Classification*, 1987 Edition[8].

6 OECD reference countries

Six countries from within the OECD have been identified by the NZ Institute of Economic Research (also see Edwards, 1992[9]) as having a number of similar characteristics to New Zealand as regards population, size of the economy and stage of economic development. These countries: Australia, Denmark, Finland, Ireland, Sweden and Norway, will be used in this report as a basis for comparison of some of the main results, and will be referred to as the "OECD reference countries".

7 Limitations of the survey data

There are limitations to the level of accuracy that can be expected from an R&D survey. Many respondents do not keep separate account of their R&D expenditure, or they may include R&D with other scientific and technological services, such as consulting. Records may not be kept in the form required for the survey, and considerable estimation may be required. Detailed descriptions of what should and should not be included as R&D were provided on the questionnaire form, and phone-in help was available and utilised. However, best estimates were required in many cases. As the survey is repeated the results can be expected to become more reliable, as respondents become more experienced.

The OECD requirement for international comparability meant that capital expenditure was requested rather than depreciation. It needs to be borne in mind that large capital expenditures can cause fluctuations in total expenditure from year to year, which can mask a trend or introduce a false trend.

The 1989/90 business enterprise survey was based on a stratified sample, whereas the last two surveys have had full coverage. Sampling error will no doubt contribute to the fluctuations noted between the two latest surveys and the 1989/90 survey, and must be taken into account when making comparisons. In some instances it appears that businesses may have reviewed their assessment of the output class into which their R&D should be classified. This seems to have occurred particularly in the information technology (IT) area, with firms stating in the second survey the purposes (health, commerce, economics) towards which their IT research was addressed, rather than simply that it was IT research.

BUSINESS

8 The business enterprise sector

8.1 Introduction

The business sector provided $204 million worth of research (equivalent to 0.30 percent of GDP). Some of the money for this research came outside the sector, from government, from local bodies, or from overseas. The business sector funded $227 million worth of research. Some of this research was carried out in the government and university sectors, or overseas.

Full-time equivalent (FTE) personnel engaged in research in this sector numbered 1934. In addition, 721 FTEs were in research associations and producer boards.

In the first year of the survey, a stratified random sample of 2,508 firms was surveyed, representing a population of 7,904 firms, research associations and producer boards, in areas of the manufacturing and service sectors which could be expected to engage in R&D. In the second and third years, a brief question on R&D activity was sent to the population of about 150,000 firms (all non-government firms in the Statistics New Zealand Business Directory). There were 2,156 firms who conducted or funded R&D in 1991/92, all of which received the full R&D questionnaire.

It was subsequently found that 941 of these (0.6 percent of the population) provided or funded R&D or traded in technology.

R&D was being done by 765 (including imputes), and 286 were funders, compared with estimates from the second year's sample of 736 providers and 265 funders.

Total research personnel comprised 1.6 per 1000 labour force.

Persons engaged in R&D in the business enterprise sector represented 30 percent of the national total of R&D personnel, compared with an average of 48 percent for the six OECD reference countries.

8.2 Concentration of R&D in firms

Excluding research associations and producer boards, the distribution of R&D expenditure was heavily concentrated in a small number of firms. Of the total of $227 million spent on research by the business sector, $72 million was spent by research associations and producer boards. The remaining $155 million was distributed as follows:

The top 5 firms spent $ 26.5 million, or 17 percent of the total.
The top 10 firms spent $ 39.4 million, or 25 percent of the total.
The top 37 firms spent $ 77.5 million, or 50 percent of the total.

Twenty-three enterprises carried out R&D to the value of $1 million or more.

8.3 Size of firms carrying out R&D

The New Zealand survey is based on the GST register, so that more very small firms are likely to be surveyed here than in other OECD countries. In small OECD countries, firms with less than 10

FTEs are rarely surveyed, and in the larger OECD countries, firms with fewer than 100 to 500 people may be excluded from the R&D survey.

Seventy-three percent of firms surveyed in New Zealand had 1 or fewer research FTEs. A further 10 percent had between 1-2 research FTEs. Seventeen percent had more than 2 research FTEs. Table 1a shows the median and total expenditures of these groups of firms.

In all groups the mean expenditure on R&D was greater than the median expenditure, which indicates that a few high spenders clustered at the upper boundaries of each group.

There are a small number of large R&D providers that carry out most of the R&D for New Zealand business.

Table 1a. Distribution of R&D carried out in firms by number of researchers employed

Researchers (FTE)	Firms		Total Expenditure		Mean Expenditure ($000)	Median Expenditure ($000)
	Number	%	$M	%		
0-0.5	409	53	17.5	9	43	23
0.5-1	152	20	17.2	8	113	80
1-2	77	10	18.3	9	237	191
2-5	74	10	38.1	19	514	406
>5	52	7	113.3	55	2,133	1142
TOTAL	765	100	204.0	100		

Table 1b. Firms spending on R&D by size of firm

Size (in FTEs)	Number of firms undertaking R&D	% of firms in each group	Research Expenditure ($ million)	% of total R&D expenditure carried out by firms in this group
0-9	383	47	30.5	15
10-19	83	10	8.2	4
20-49	100	12	20.4	10
50-99	72	9	26.5	13
100-199	74	9	38.8	19
200-499	59	7	40.8	20
>500	38	5	38.8	19
TOTAL	765	100	204.0	100

Table 1b shows that a total of 69 percent of the firms have <50 FTEs and they account for 29 percent of R&D expenditure; a significant contribution. Twenty-one percent of firms have >100 FTEs. They account for 58 percent of R&D expenditure. Five percent of firms have >500 FTEs. Thus, this small number of large firms accounts for 19 percent of R&D expenditure.

8.4 R&D Expenditure for small vs large firms by industry group

It has often been argued that most R&D is done by large firms (> 100 FTEs). Our preliminary data, however, suggests a more important R&D role for smaller firms than hitherto realised. For example, fifteen percent of business R&D is done by firms with fewer than 10 staff (FTE). In most small OECD countries, firms with fewer than 10 staff are not even included in the R&D survey. Firms with fewer than 100 FTE carry out 42% of the total business enterprise R&D.

We examined four sectors in detail, from a small R&D investor (the textiles sector) to a large investor (all services other than utilities, construction, transport, communications, R&D and engineering services, i.e. wholesale and retail trade, business and financial services including software, community, health services).

Research associations and producer boards were excluded from the R&D data. It was not possible to extract them from the "all firms data", so the ratios will be slight underestimates.

Table 2. R&D statistics for small firms in four industry sectors

Industry Sector	Total R&D firms in this Sector	Small Firms (< 100 FTEs)				
		Number	R&D Expenditure ($ million)	% of R&D in this sector	% of R&D firms in this Sector	% of total firms in this sector
Other services	276	246	19.1	45	89	0.2
Electrical Mfg	70	58	6.3	36	83	9.8
Mfg Food, bev	73	43	4.6	24	59	2.5
Mfg Textiles	32	19	1.5	42	59	0.9

Even in a small R&D investor like the textile industry, the smaller firms doing R&D make up 59 percent of the firms doing R&D and carry out 42% of the total R&D for the sector. Further analysis showed that small R&D firms employ relatively high numbers of total staff, in comparison to other small firms. Small R&D firms make up 0.9 percent of the total of small firms; however, these small R&D firms account for 4.5 percent of FTEs.

In the sectors examined, smaller firms carry out 24 to 45 percent of the R&D in the sector, and make up 60 to 90 percent of firms doing R&D in the sector. They represent between 0.2 and 9.8 percent of the smaller firms in their respective sectors, and between 0.5 and 20 percent of total employees in small firms in their sector.

An analysis of 26 industry groups showed that large firms had an average of 5.48 research personnel per company and that they spent, on average, $91,300 per research personnel. Small firms had 1.36 research personnel per company and spent $69,500 per research personnel.

9 Intramural business enterprise R&D, by science output class

9.1 Overview of R&D by output

In addition to classifying firms by NZSIC, R&D in New Zealand can be grouped by science output class. Output classes are New Zealand government science funding categories, used in setting priorities and making funding allocations for public good research, either individually or grouped by the 24 science areas.

Each firm was asked to state the output class which best described the purpose of its R&D. In some instances firms may confuse this with the nature of the R&D, e.g. R&D developing agricultural machinery may be coded to Output Class 18 instead of the appropriate agricultural output.

Figure 1 shows expenditure on all R&D carried out between 1989/90 and 1991/92 by business enterprises, according to science output class group. Note: this is not the same as amount funded by the private sector in each output category. Business enterprises include industry research associations and producer boards (see Table 7) which spent $45.9 million on intramural R&D in 1991/92 ($52.9 million in 1990/91).

In Table 3, the same information is grouped by the 24 strategic science areas. These groups combine science output areas for the same sector (in terms of production and processing). This table, therefore, is useful for comparing expenditure levels in each sector including production and processing. Details of New Zealand's science output classification system and the 38 science output classes are given in Annex 3.

The total expenditure on R&D carried out by the business enterprise sector decreased marginally between 1990/91 and 1991/92, by $0.3 million, to $204.1 million. The way in which enterprises responded to the survey definitions may account for small fluctuations in the total expenditure, or for changes within output classes. So, the significance of small variations must be evaluated carefully.

Now that figures for three consecutive years are available and trends can be inferred, primary processing and primary products are seen to be the only major sectors to have shown a consistent increase in business R&D expenditure since 1989/90. Combined, they comprised 42.6 percent of intramural business enterprise R&D in 1991/92, 42.0 percent in 1990/91 and 39.5 percent in 1989/90.

Table 3 shows that over a quarter of the R&D is aimed at the development of new and improved materials and industrial processes, engineering products and processes, and computing, electronic, telecommunication and instrumentation processes, systems and products. R&D reported in this area recovered slightly to $55.5 million after a decrease in 1990/91.

A fifth of the research is aimed at the development of improved infrastructure and services. These include: construction, commercial and trade services, energy, transport, information and communication services, and urban and rural planning. R&D in these areas showed the most significant decrease, dropping by $5.1 million to $40.9 million, between 1990/91 and 1991/92.

In 1991/92, business enterprises targeted $10.9 million (5 percent of total) at health research, a small increase over the previous year. Research aimed at the protection of the environment (which includes pollution and waste management), research into natural resources and the environment, and research into fundamental knowledge has been declining. These comprised 3.3 percent of total intramural BERD in 1989/90, 2.0 percent in 1990/91 and 1.8 percent in 1991/92. Reported research on social development, including economic research, declined slightly in 1991/92.

9.2 Primary production (Output Classes 01 to 10)

Figure 1 shows that private sector R&D in primary production received a proportionately low level of funding compared to other areas of research. Expenditure increased slightly to $16.8 million but the number of enterprises reporting fell by 2 percent. Internationally, primary production R&D is not normally well funded by the private sector.

Primary production involves 10 output classes. Eight of these are agricultural with one each devoted to forestry and fishing. For confidentiality reasons expenditure figures cannot be shown for generic animal research; funding has declined since 1989/90, however.

9.3 Primary products and processing (Output Classes 11 to 15)

The substantial expenditure in this group of output classes reflects the economic importance of these primary products in the New Zealand economy, and the presence of research associations and producer and marketing boards in the meat, dairy, wool and fruit sectors. Expenditure in this group increased by $2.1 million to $71.3 million. The number of companies reporting intramural expenditure on R&D increased by 13 percent. This is a notable increase compared to the other major groups shown in Figure 1.

Within the overall group of output classes, the most noticeable increases in funding occurred in research into New and Improved Meat Processes, Storage Techniques and Products (Output Class 11), and other food processing (Fruit, Crops and Other Food and Beverage Processes, Storage Techniques and Products - Output Class 13). The former increased by 25.4 percent to $14.0 million, the latter increase by 27.6 percent to $10.1 million. Also, Output Class 13 showed an 18 percent increase in the number of companies reporting R&D expenditure in 1991/92. Overall, business enterprises spent $28.5 million on research aimed at the development of New and Improved Dairy Processes, Storage Techniques and Products (Output Class 12). This is the largest of all the output classes in the business enterprise sector in 1991/92, and has changed little aside from a small increase in 1990/91.

R&D into processing and products from natural and artificial fibres, textiles, clothes and skin products, including leather (New and Improved Fibres and Skin Processes and Products - Output Class 14) fell to $12.6 million, similar to the 1989/90 figure. In 1990/91, $14.6 million had been spent. Wood and Paper Processes and Products (Output Class 15) fell for the second consecutive year despite a 14 percent increase in the number of companies reporting in 1991/92. This year, expenditure fell by $1.5 million to $6.1 million.

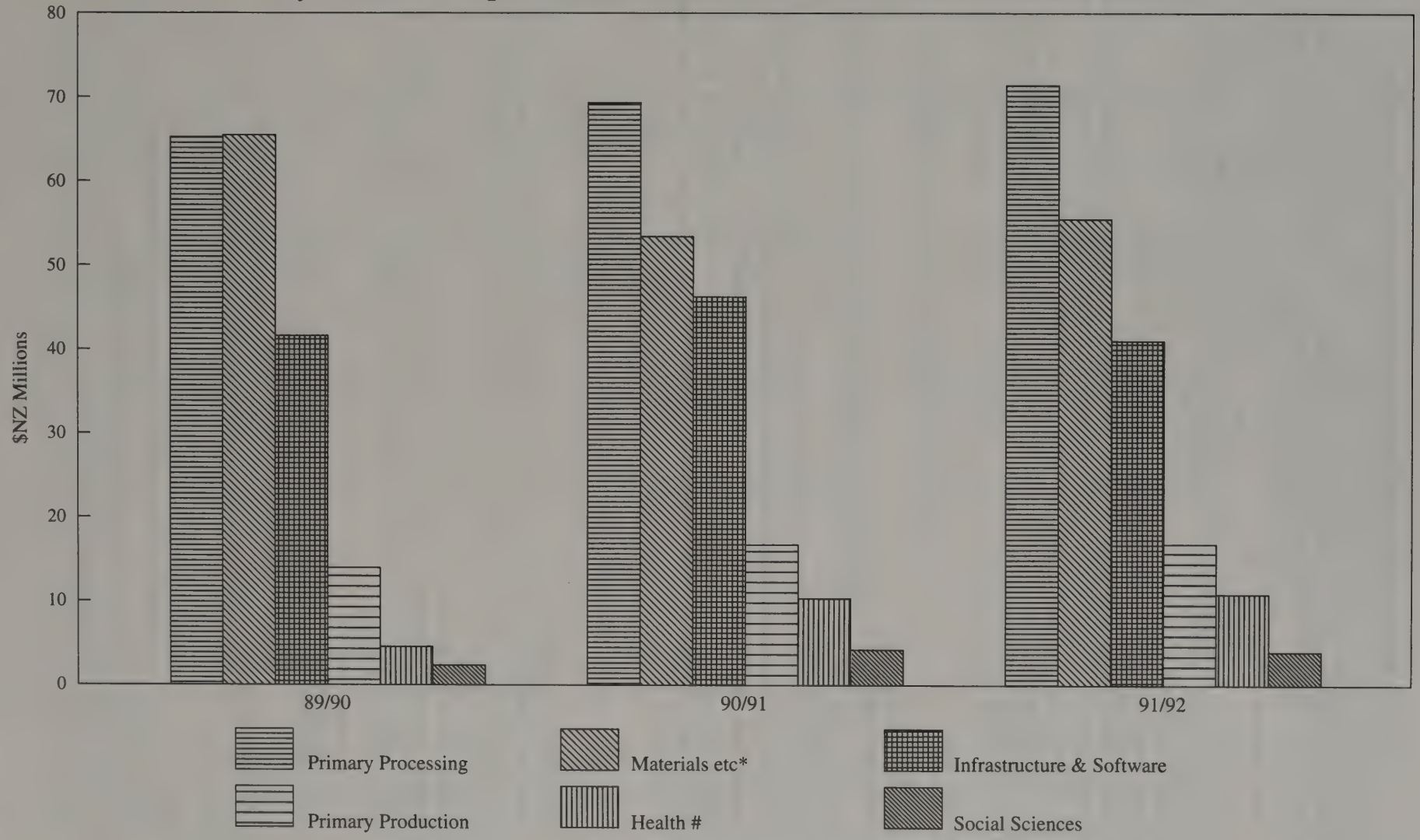
9.4 Materials, engineering, computing and communications (Output Classes 16 to 18)

There was a small increase in the number of companies reporting intramural expenditure (0.9 percent). Expenditure in this group did increase slightly from the previous year, although expenditure is still about $9.5 million less than in 1989/90.

Of the $55.5 million in this group, $17.9 million is spent on research aimed at New and Improved Computing and Electronic, Communication and Instrumentation Processes, Systems and Products (Output Class 18). This is $1.7 million less than was reported in 1990/91. In 1989/90 this was the highest expenditure on intramural R&D of all the output classes. However, the wording of Output

Figure 1

Intramural R&D Expenditure (Business Enterprise Sector) By Science Output Class (Excl. Environment, Fundamental Knowledge & Defence)



* New and Improved; Materials, Processing, Engineering, Hardware & Electronics.
\# Health: Incomplete Coverage 1989/90.

Table 3. Intramural business enterprise R&D by strategic science area

Strategic Science Areas	1991/92		1990/91	1989/90
Output Aggregation	Number of firms	R&D Expenditure ($000)	R&D Expenditure ($000)	R&D Expenditure ($000)
01 Sheep Production 02 Beef Production 11 Meat Processing 14 Fibre, Textiles & Skin Processing	86	31,109	29,822	24,055
03 Dairy Production 12 Dairy Processing	53	30,185	31,808	31,054
04 Alternative Animal Species	13	478	1025	1082
05 Generic Animal Research	n.p.	n.p.	n.p.	n.p.
06 Forage Plants	14	2,852	1,785	1,426
07 Horticulture 08 Arable Crops & other Plants 13 Other Food Processing	93	14,130	10,725	10,150
09 Plantation Forestry 15 Wood & Paper Processing	74	8,704	9,445	9,780
10 Fisheries	13	486	1,071	1,094
16 Materials & Industrial Processing 17 Engineering 18 Electronic & Instruments	310	55,491	53,235	65,186
19-24 Infrastructure	220	40,908	46,036	41,590
19 Construction		7,099	5,392	4,785
20 Commercial & Trade		4,561	8,099	4,735
21 Energy		5,430	5,665	5,549
22 Transport Services		2,860	3,246	4,341
23 Information & Communication		20,577	23,271	21,662
24 Urban & Rural Planning		383	364	518
25 History, Society & Culture 26 Relationships & Wellbeing 27 Political & Economic Relationships 28 Education, Knowledge & Training	34	4,079	4,237	2,285
29 Environment Protection 30 Geological Structures & Processes 31 Land Use, Flora & Fauna 32 Marine & Fresh Waters 33 Climate & Atmosphere	43	3,701	3,794	5,660
34 Space 36 Fundamental Knowledge	7	106	245	1,076
37 Health	42	10,855	10,342	4,466
38 Defence	n.p.	n.p.	n.p.	n.p.
TOTAL (includes "Other")	765	204,090	204,400	200,048

n.p. = Not for publication to protect confidentiality of responses.

Classes 18, and 23 (Information Processing and Communications Services) was clarified in the 1990/91 questionnaire, which could account for some repositioning of R&D between these classes. Some firms engaged in software R&D were sold or became distributors. There were increases in other research output classes for firms in the financial and software services industry group, indicating that some of this research was simply classified to different output classes.

New and Improved Materials, Industrial Processes and Products - Output Class 16 - from chemicals, petroleum and coal, base metals and glass, including plastics, rubber and pharmaceutical, accounted for R&D of $14.2 million in 1991/92, a fall of $1.3 million. Engineering Processes, Systems and Products - Output Class 17 (manufacturing, automation and production technologies for fabricated metal products, transport equipment, agricultural machinery and mechanisation, appliance and electrical equipment, and industrial and construction machinery and equipment) is now the largest sector in this group. It accounts for $23.4 million and has increased significantly by $5.3 million. Most of this additional expenditure went into research on construction machinery ($2.4 million), electrical machinery ($1.6 million), transport equipment ($1.1 million) and into agriculture, forestry and fishing ($0.8 million).

9.5 Infrastructure and services (Output Classes 19 to 24)

There has been an 11 percent reduction in intramural business expenditure in this group in 1991/92 although the number of companies reporting expenditure increased 1.6 percent.

This grouping includes R&D in construction and building ($7.1 million), commercial and trade services including tourism (down $3.5 million to $4.6 million), energy ($5.4 million), transport ($2.9 million), and urban and rural planning ($0.4 million). Intramural expenditure in commercial and trade services is principally in financial and software development and in engineering scientific services. In 1990/91 this increased by $3.3 million, but this year it has returned to just below the 1989/90 level.

A little over half of the $40.9 million of R&D in this grouping ($20.6 million) was spent on new and improved information and communication services, including computer software, information processing, library and related information services, broadcasting, telecommunications, postal and other communications services. This is the same proportion as last year but there was a reduction in intramural R&D expenditure on financial and software services of $2.7 million. Much of the research in this output involves computer software research. When this output is combined with output 18 which represents electronics including communications hardware, it is clear that information systems comprise a large area of business enterprise sector R&D in New Zealand. The two outputs total $38.5 million in 1991/92 ($43 million in 1990/91), or 19 percent of all the business enterprise R&D (21 percent in 1990/91).

9.6 Social sciences, environment, natural resources and fundamental knowledge

Social sciences, environment, natural resources and fundamental knowledge are not well funded by the business enterprise sector. Overall, the social sciences received a similar level of funding to last year, although there was a decrease in the area of politics and the economy ($800,000), and an increase in the relationships and well-being category ($600,000). There was another decrease in money spent on environmental research (down by $380,000 in 1991/92 after a $700,000 decline in 1990/91). Intramural R&D into natural resources (minerals, land, flora and fauna, marine and fresh water ecosystems and the atmosphere) and fundamental research with no particular application in view, increased slightly, although spending is still well down on 1989/90. Expenditure on space and fundamental knowledge are the main losers from this reduction in expenditure since 1989/90.

9.7 Health and defence

Expenditure on R&D in health increased 4.9 percent to $10.9 million in 1991/92. Questionnaire results for last year's Business Directory Update (published by Statistics New Zealand) identified several enterprises, not identified in the 1989/90 survey, engaged in health research.

Expenditure on R&D for defence increased by $145 thousand.

10 Funding of R&D expenditure in the business sector

10.1 Source of funds for intramural R&D

In the survey, enterprises were asked to provide information on the sources of funds for their R&D. The results are summarised in Table 4.

The business enterprise sector used its own funds, the funds of other firms and government, and overseas sources in order to carry out its intramural R&D of $204.1 million.

Sixty-eight percent of the R&D was funded by the organisations doing the work in 1991/92 and 1990/91, but this is below the 1989/90 level. In 1991/92, a further 12 percent came from related New Zealand private sector enterprises, and 8 percent from unrelated enterprises. (Related enterprises are those which share with the survey respondent a direct investment relationship and/or a common management structure).

Twelve percent of the research performed in the business enterprise sector was funded from outside the sector (from overseas and government), which was slightly more than last year. The contribution from the New Zealand central government increased to 6.8 percent in 1991/92. Contributions from related private enterprises abroad was 2.5 percent, down from 3.8 percent in 1990/91, and unrelated private enterprises abroad contributed 1.9 percent.

Of the funds coming from outside the business enterprise sector, $14.0 million came from the government sector. A further $9.0 million came from overseas. The equivalent 1990/91 figures are $12.6 million from government and $9.8 million from overseas. Firms have maintained funding from their own sources although there appears to be an appreciable decline in funds (down $7.1 million) from related firms within New Zealand and overseas. This has been partially offset by an increase in funds from unrelated firms (up $3.5 million). Enterprises were also able to offset this by expanding other sources of funds - enterprises' own funds ($0.6 million), NZ government funds ($1.4 million), NZ local government ($0.6 million), and other unspecified sources ($0.7 million).

The proportion of industry funds used for R&D carried out by the New Zealand business enterprise sector (88 percent) is in line with the six OECD reference countries, where this figure averages 88 percent for the most recent available years. The portion of business enterprise R&D financed by government is 7.3 percent, lower than the average OECD reference country figure (9 percent).

10.2 Additional research funded but not performed in the sector (extramural R&D)

In addition to the R&D carried out within the business enterprise sector, business enterprises reported that they funded $18.8 million worth of research by government organisations, $0.6 million by local authorities, $8.8 million by the universities, and $18.2 million overseas. This total of $46.4 million

was research funded by the business sector and carried out outside the sector. This compares with $31.0 million in 1990/91.

The survey asked firms to report any amounts paid in levies to another organisation, where the levy contained an unknown component for R&D. The total reported in the survey included levies paid to New Zealand firms already included in the survey, and $3.6 million paid in levies to overseas firms. Further investigation shows that less than $2.3 million of these levied funds would have been used for R&D.

Table 4. Source of funds for intramural business enterprise R&D, 1991/92

Source of funds	1991/92		1990/91		1989/90	
	($000)	%	($000)	%	($000)	%
Own Funds	138,584	67.9	138,005	67.5	141,285	70.6
Related Private NZ Firm	23,960	11.7	28,557	14.0	28,737	14.4
Unrelated Private NZ Firms	16,552	8.1	14,777	7.2	5,643	2.8
NZ Central Government	13,980	6.8	12,593	6.2	12,951	6.5
NZ Local Government	937	0.5	347	0.2	572	0.3
Overseas Funds From Related Firms	5,146	2.5	7,689	3.8	5,472	2.7
Overseas Funds From Un-related Firms	3,840	1.9	2,096	1.0	4,911	2.5
Other Sources of Funds	1,090	0.5	317	0.2	477	0.2
TOTAL	204,090	100	204,400	100	200,048	100

Note: NZ Tertiary Education Sector included in NZ Central Government. Columns will not always agree with totals shown due to rounding of individual estimates.

10.3 Extramural R&D, by industry group

Table 5 provides information by industry group about all R&D funded by a business enterprise but carried out by other enterprises, institutions or individuals. This includes R&D funded at other business enterprises which had already been reported as intramural R&D by the provider. A total of $101.6 million was spent on extramural R&D, if funds circulating within the sector are included.

Table 5. Extramural R&D funded by business enterprises, 1991/92 by industry group

Industry of Enterprise		Number of Enterprises	Sector of Recipient of R&D Funding, ($000)				Total ($000)	Increase since 1990/91
NZSIC Codes	**Description**		**Government***	**Universities**	**Other Business Enterprises**	**Overseas Organisations**		**($000)**
1000	Agriculture, forestry and fishing	24	702	n.p.	241	n.p.	1,425	+423
2000,371,372,381	Mining, basic metals and metal fabrication	11	90	112	n.p.	n.p.	558	-68
351,352,353,354	Chemicals (fertilizers, pesticides, paint, drugs)	25	748	283	928	2,223	4,181	+752
310,320,355,356	Food, textiles, plastics production	49	1,072	282	1,533	2,940	5,826	+1,140
3830,3832	Electrical machinery (electronic, appliances) **	9	n.p.	n.p.	n.p.	951	1,170	-2,394
3820,3825,3850	Machinery (industrial, office, instruments)**	9	n.p.	n.p.	959	0	1,157	-280
330,340,360,384, 390	Other manufacturing (wood, paper, concrete), transport equipment	18	1,890	61	719	832	3,502	+4
4000 - 7000	Infrastructure services (includes most producer boards)**	64 (6)	7,302 (5,935)	3,715 (1,630)	42,611 (n.p.)	10,287 (n.p.)	63,915 (51,585)	+11,507 (+6,581)
8000 except 8324	Financial, Software development services	n.p.	n.p.	n.p.	942	478	1,471	+984
8324,9000	Engineering, scientific services	62	n.p.	4,057	6,933	n.p.	18,405	+6,424
1000-9000	Total 1991/92	286	19,488	8,771	55,183	18,169	101,611	+19,052
1000-9000	Total 1990/91	265	10,366	7,661	51,519	13,012	82,559	+5,564 •
1000-9000	Total 1989/90	315	12,160	6,092	44,357	14,387	76,995	

* Local authorities are included in the Government column.

** Producer board sub-totals are shown in brackets ( ) and included in row totals
Adjacent cells have been amalgamated where necessary to protect confidentiality.

• Increase since 1989/90.

Funders of R&D stated that other business enterprises were funded a total of $55 million, of which $39 million went to an enterprise related to the funder. Some of these funds may have been reported twice, as it is not uncommon for funds for research to be sub-contracted or passed to a funding organisation to be allocated; in which case, both funders would report the same R&D. Also, as noted above, this research has already been counted among the responses from R&D providers. See Table 15 for an estimate of business enterprise expenditure which is based on provider information.

Of the total of $18 million spent on R&D carried out overseas, $17 million went to an overseas enterprise related to the funder.

The amount stated as spent with government is very close (within $0.5 million) to that reported by government departments in the government survey.

Most of the funds spent on R&D undertaken by another organisation occurred in the infrastructure services sector, which includes most of the producer boards. The figures for the producer boards are shown in brackets in Table 5. Of the $64 million from this sector, $43 million was spent with local private sector enterprises, $7.3 million in the government sector, and $10.3 million overseas. Producer boards spent $52 million of the total.

Engineering and scientific services businesses were the next largest source of funds for extramural R&D. This group spent $6.4 million more than in the previous year. The universities and other enterprises were the main research providers to this industry group.

Of the remaining industry groups, the electrical industry spent $2.4 million less than the previous year, and the food, textiles and plastics industries spent more, 50 percent being spent overseas. The other manufacturing (wood, paper and concrete) group used mainly government research providers, whereas the chemical industry spent most of its extramural funds overseas.

10.4 Total R&D funded by the business enterprise sector

Total research funding by the business enterprise sector increased from $212.6 million in 1990\91 to $227.5 million. This is obtained from total R&D performed ($204.1 million) by subtracting R&D funded from outside ($23 million) and adding R&D funded by but not performed in the sector ($46.4 million).

10.5 Intramural estimate of total R&D funded by the business enterprise sector, by output class

Total funding on R&D by the business enterprise sector includes R&D financed and carried out by the sector, and R&D paid for by the sector and carried out by government or other organisations outside the business enterprise sector, or carried out overseas.

It is estimated that the business enterprise sector funded $227.5 million of R&D in 1991/92. This does not include any part of the $2.3 million paid to overseas firms as levies which may or may not be used for R&D. Flows of funds for R&D usually include only funds both intended and used for R&D.

Table 4 shows that business enterprises carried out R&D in-house to the value of $180 million with their own funds or with funds from other business enterprises. Table 5 shows that business enterprises also funded R&D to the value of $46.4 million extramurally in other sectors (in the universities, government or overseas).

Table 6. Estimates of business enterprise expenditure on R&D, 1991/92

Science output class	R&D funded, ($000)		
	Intramural	Extramural	Total
01 Sheep Production	4,074	3,882	7,956
02 Beef Production	187	776	963
03 Dairy Production	1,577	383	1,960
04 Alternative Animal Species	469	208	677
05 Generic Animal Research	n.p.	n.p.	n.p.
06 Forage Plants	1,830	784	2,614
07 Horticulture	1,765	2,923	4,688
08 Arable Crops & other Plants	959	359	1,318
09 Plantation Forestry	1,947	362	2,309
10 Fisheries	458	112	570
11 Meat Processing	11,529	1,573	13,102
12 Dairy Processing	26,014	4,676	30,690
13 Other Food Processing	9,985	6,389	16,374
14 Fibre, Textiles & Skin Processing	10,415	3,787	14,202
15 Wood & Paper Processing	5,833	1,855	7,688
16 Materials & Industrial Processing	11,876	3,925	15,801
17 Engineering	21,868	279	22,147
18 Electronic & Instruments	16,676	1,453	18,129
19 Construction	6,090	704	6,794
20 Commercial & Trade Services	4,167	734	4,901
21 Energy	4,946	1,981	6,927
22 Transport	1,980	246	2,226
23 Information & Communication	20,097	136	20,233
24 Urban & Rural Planning	126	194	320
25 History, Society & Culture	28	0	28
26 Relationships & Wellbeing	883	794	1,677
27 Political & Economic Relationships	1,719	331	2,050
28 Education, Knowledge & Training	660	527	1,187
29 Environment Protection	1,358	228	1,586
30 Geological Structures & Processes	693	52	745
31 Land use, Flora & Fauna	25	340	365
32 Marine & Fresh Waters	30	0	30
33 Climate & Atmosphere	n.p.	0	n.p.
34 Space	n.p.	0	n.p.
35 Antarctica	n.p.	0	n.p.
36 Fundamental Knowledge	73	0	73
37 Health	8,898	7,545	16,443
38 Defence	702	0	702
TOTAL	180,183	47,594	227,777

n.p. = Not published for reasons of confidentiality

There was a difference between the total value of R&D that enterprises said they had carried out with funds from other enterprises ($43 million - see Table 4), and the total that funders said they paid to other business enterprises to provide R&D ($55 million - see Table 5). Providers responding to the survey are judging the R&D that they perform against the definitions provided, so their response is more likely to be correct. There may also be double-counting among funders.

To obtain the estimates in Table 6, funding from government and overseas was deducted from the value of each enterprise's intramural R&D, in the same proportion per output class as the proportion for total research carried out. This provides the intramural R&D funded solely by business enterprises, shown in column two of Table 6.

Business financed extramural R&D carried out by universities, government or overseas had to be allocated to output classes, because the survey asked only for the total. If the enterprise carried out R&D it was assumed that it would fund in the same output areas. If it simply funded R&D then the industrial classification was used to allocate the funds to the most likely outputs. The resulting estimates, total extramural expenditure on R&D in each output by the business enterprise sector, are shown in the third column.

Dairy processing is the largest single target of private sector R&D funds, with $31 million spent in New Zealand or overseas.

Output Classes 18 (electronics and instruments), and 23 (information and communications services) should be considered together. The first includes the "hardware" aspects of computer microprocessor and communications R&D, and the second is "software" R&D, into new programming languages and operating systems. These two areas are closely linked. Together they account for 19 percent of private sector funding for R&D, and 21 percent of all research carried out in the private sector.

Fibre, textiles and skin processing - Output Class 14 ($14 million), materials and industrial processes - Output Class 16 ($15 million), and engineering processes - Output Class 17 ($22 million) are the next largest areas of business enterprise funding.

11 Intramural business sector R&D, by industry group

In Sections 9 and 10, R&D undertaken by business enterprises is analysed according to science output class. The output class is an indication by respondents of the purpose of the research.

The results of the survey have also been analysed according to the industry to which the enterprises undertaking the R&D belong, using the NZ Standard Industrial Classification (NZSIC). To protect confidentiality, while providing the maximum amount of additional information, enterprises were grouped into 11 industry groups. These are illustrated in Figure 2 and given in Table 7.

In this analysis, and throughout this report, the research associations are classified to the industry group that they predominantly serve. As the Statistics New Zealand Business Directory is updated annually, an enterprise may be reclassified to a new NZSIC if its predominant activity has changed.

The expenditure, in all levels combined, showed a marginal drop of 0.15 percent. However, within industry groups, major differences were seen. Of the 11 industry groups, seven showed increased expenditure:

Figure 2

Intramural R&D Expenditure (Business Enterprise Sector) By Industry Group, 1989/90 - 1991/92

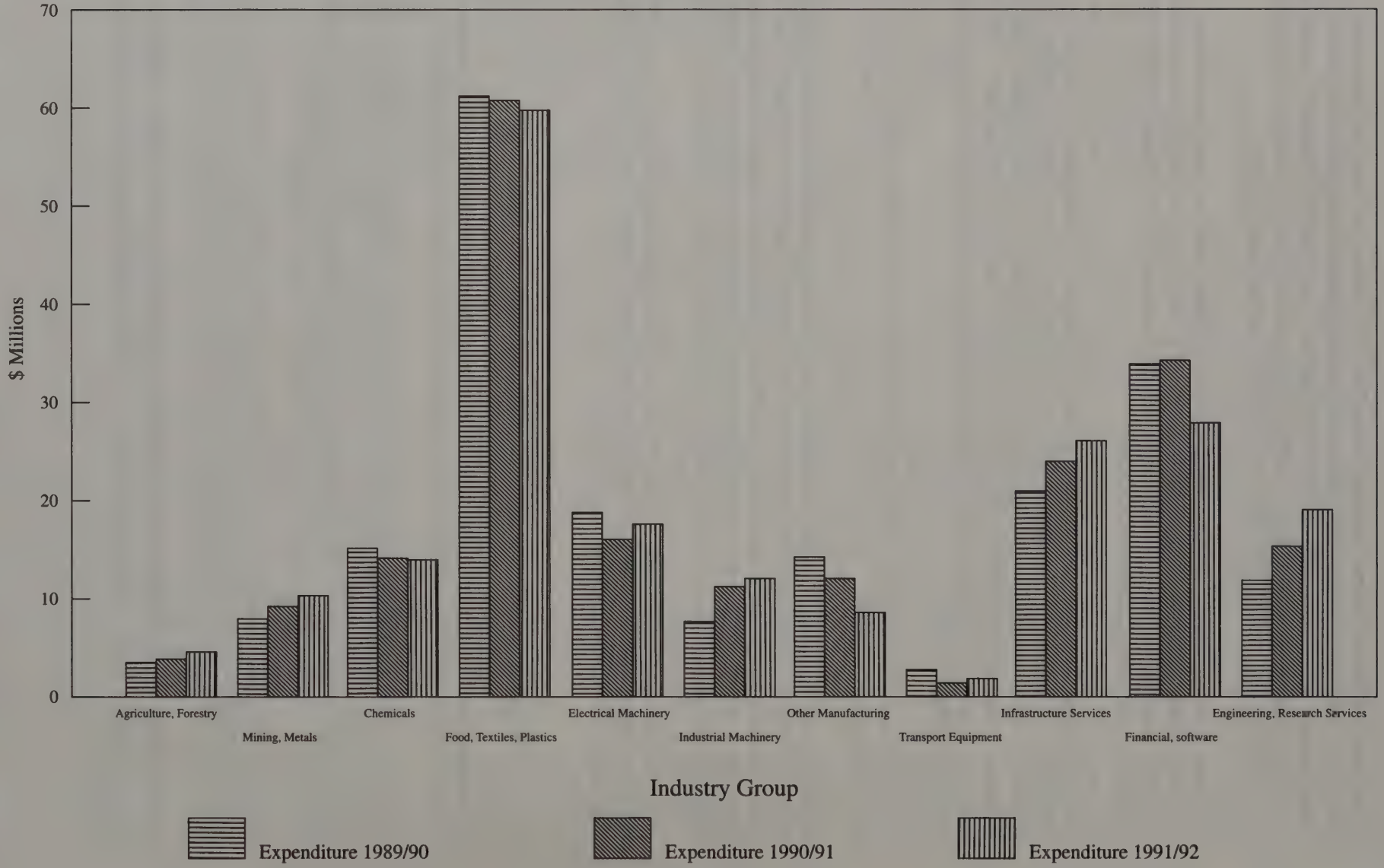


Table 7. Intramural business enterprise R&D expenditure, by industry group, 1991/92

NZSIC group	Industry group	Expenditure 1991/92	Expenditure 1990/91	Expenditure 1989/90
		Total ($000)	Total ($000)	Total ($000)
1000	Agriculture, forestry and fishing	4,579	3,722	3,418
2000, 371, 372, 381	Mining, basic metals and metal fabrication	10,393	9,291	7,923
351, 352, 353, 354	Chemicals (fertilizers, pesticides, paint, drugs)	14,121	14,323	15,363
310, 320, 355, 356	Food, textiles, plastics production	60,093	61,222	61,630
3830, 3832	Electrical machinery (electronic, appliances)	17,823	16,275	18,959
3820, 3825, 3850	Machinery (industrial, office, instruments)	12,246	11,391	7,726
330, 340, 360, 390	Other manufacturing (wood, paper, concrete)	8,820	12,219	14,469
384	Transport equipment (railroad etc)	1,826	1,543	2,902
4000 - 7000	Infrastructure services	26,440	24,264	21,222
8000 Except 8324	Financial, software development services	28,286	34,488	34,361
8324,9000	Engineering, scientific services	19,463	15,663	12,074
Producer Boards and Research Associations*		* 45,892	* 52,867	not available
1000-9000	**TOTAL**	204,090	204,090	200,047

* Data also included in the Total column

- Engineering, Scientific Services showed the largest increase ($3.8 million - 19.5 percent), to $19.5 million;
- The next largest percentage increase (18.7 percent) occurred in Agriculture, Forestry and Fisheries ($3.7 million to 4.6 million);
- Infrastructure Services increased by $2.2 million, to $26.4 million;
- Mining, Basic Metals and Metal Fabrication increased by $1.1 million; to $10.3 million; and
- Other increases occurred in Electrical Machinery, Machinery, and Transport Equipment.

Four categories showed reduced R&D expenditure:

- Food Textiles and Plastic Production dropped by $1.1 million, although at $60.1 million it is still, by far, the largest spender on R&D;
- Other Manufacturing, including wood, paper, and concrete showed the largest percentage drop in funding (28 percent - $8.8 million to $3.4 million);
- Financial Software development decreased by $6.2 million, to $28.3 million; and
- Chemicals dropped by $200 thousand, to $14.1 million.

Firms are now becoming experienced in responding to the R&D survey, and it is expected that consistency of reporting will continue to improve. In the future, improved consistency of reporting may mean that data from earlier surveys may need adjusting, if long-term trends are to be extrapolated.

12 Type of R&D expenditure in the business sector

Enterprises were asked to indicate how they spent their R&D funds. Results are given in Table 8.

Wages and salaries consumed 54 percent of the $204 million allocated to R&D in the business enterprise sector, which is almost identical to that in the previous period. Other current expenditures accounted for 37 percent, compared with 36 percent in 1990/91. Capital expenditures were 9 percent, compared with 10 percent in 1990/91.

13 Number of enterprises and R&D staff, by industry group

In Table 9, statistics are given for 11 industry groupings on the number of enterprises undertaking R&D, expenditure on intramural R&D, and full-time equivalent R&D personnel.

The survey shows a rise of 53 in personnel doing R&D. There was an increase of 35 FTEs in the engineering and scientific services.

The last columns show the expenditure on R&D per full-time equivalent R&D staff member, an indicator of R&D intensity. This was highest for Other Manufacturing R&D (wood, paper and concrete) followed by that of Infrastructure Services.

Ministry of Research,
Science and Technology
Te Manatu Putaiao

RST:11-8:PW

5 September 1994

NEW ZEALAND RESEARCH AND DEVELOPMENT STATISTICS, ALL SECTORS, 1991/92

I enclose a complimentary copy of this report of the national R&D survey, for the use of your organisation.

This survey is repeated on an annual basis to provide information necessary for the development of science and technology policy including the setting of research priorities, monitoring human resources in science and technology and Government research funding levels. This is the third year for which this information has been collected to international standards.

The research covered by this survey includes that funded by business and research associations, the public good science fund and operational research funded under departmental votes and university research. It is gratifying to find that organisations are willing to take the time to provide information which will assist in the promotion of the national research effort.

Collection of data for the 1992/93 year is nearly complete. Trends may be identified as the collection proceeds over time that may assist in the assessment of New Zealand's capabilities and opportunities.

Further copies may be obtained from this Ministry at $10.00 per copy.

Yours sincerely

Pamela Walker-Mulcahy
Science Resource Analyst

Encl:

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Table 8. Type of R&D expenditure, by industry group, 1991/92

Industry of Enterprise		Type of Expenditure, ($000)			
NZSIC Codes	Description	Wages and Salaries	Other Current Expenditure	Capital Expenditure	Total
1000	Agriculture, forestry and fishing	2,232	1,561	785	4,579
2000,371,372,381	Mining, basic metals and metal fabrication	6,130	3,565	696	10,391
351,352,353,354	Chemicals (fertilizers, pesticides, paint, drugs)	7,792	4,608	1,720	14,121
310,320,355,356	Food, textiles, plastics production	31,425	23,528	5,139	60,092
3830,3832	Electrical machinery (electronic, appliances)	10,712	6,099	1,013	17,823
3820,3825,3850	Machinery (industrial, office, instruments)	7,462	4,321	463	12,246
330,340,360,3843,90	Other manufacturing (wood, paper, concrete), transport equipment	4,647	4,034	1,964	10,646
4000 - 7000	Infrastructure services	12,925	9,606	3,909	26,440
8000 Except 8324	Financial, software development services	15,504	11,662	1,118	28,284
8324,9000	Engineering, scientific services	11,294	6,518	1,651	19,463
1000 - 9000	**TOTAL (1991/92)** (Includes Research Associations)	110,123	75,502	18,460	204,085
	Percent	54.0	37.0	9.0	100.0
	(Research Associations)	25,874	16,511	3,508	45,892
1000-9000	**TOTAL (1990/91)** (Includes Research Associations)	109,922	73,810	20,668	204,400
	Percent	53.8	36.1	10.1	100.0
1000-9000	**TOTAL (1989/90)** (Includes Research Associations)	114,248	63,599	22,200	200,048
	Percent	57.1	31.8	11.1	100.0

Table 9. Number of enterprises and R&D staff, by industry group, 1991/92

NZSIC Codes	Industry of Enterprise	Enterprises undertaking R&D				R&D Personnel FTE				R&D Expenditure per FTE ($000)			
		1991/92		1990/91	1989/90	1991/92		1990/91	1989/90	1991/92		1990/91	1989/90
	Description	All	Producer Boards & Research Assns*	All	All	All	Producer Boards & Research Assns*	All	All	All	Producer Boards & Research Assns*	All	All
1000	Agriculture, forestry and fishing	28	n.p.	22	6	57	n.p.	57	49	80	n.p.	65	70
2000,371,372,381	Mining, basic metals and metal fabrication	48	n.p.	52	76	139	n.p.	111	97	75	n.p.	84	82
351,352,353,354	Chemicals (fertilizers, pesticides, paint, drugs)	53		51	108	178		188	240	79		76	64
310,320,355,356	Food, textiles, plastics production	133	5	137	210	883	538	874	910	68	60	70	68
3830,3832	Electrical machinery (electronic, appliances)	55		47	129	307		283	360	58		58	53
3820,3825,3850	Machinery (industrial, office, instruments)	56		57	55	170		149	127	72		76	61
330,340,360,390	Other manufacturing (wood, paper, concrete)	60	n.p.	59	97	79	n.p.	119	146	112	n.p.	103	99
384	Transport equipment (railroad etc)	11		17	23	21		27	29	85		57	100
4000 - 7000	Infrastructure services	96	4	106	42	264	91	251	283	100	92	97	75
8000 Except 8324	Financial, software development services	100		97	174	289		310	379	98		111	91
8324,9000	Engineering, scientific services	125	n.p.	91	109	269	n.p.	234	206	72	n.p.	67	59
1000-9000	**TOTAL**	765	14	736	1,027	2,656	696	2,603	2,826	77	66	79	71

* Producer Boards and Research Associations are also included in "All" data

n.p. = Not published for reasons of confidentiality.

GOVERNMENT

14 Government sector intramural R&D, by science output class

14.1 Introduction

The government sector provided $317.2 million worth of research (equivalent to 0.45 percent of GDP). By far the majority of the majority of these funds came from within the sector (mostly from FRST funding). By far the majority of extramural R&D funded by government was provided by other agencies of NZ central government. A total of 3855 FTEs were employed in CRIs and government departments; in addition, 2326 FTEs were employed in the university sector. Government figures include a second capital payment of $13.3 million for the marine research vessel "Tangaroa".

During 1991/92 the main government science departments underwent major restructuring. On the 1st of July 1992 10 Crown Research Institutes (CRI's) commenced operations and the DSIR, MAF Technology, FRI and the Met Service ceased to exist.

During this year, the main sources of funds for research in the government sector were allocations from the Public Good Science Fund administered by the Foundation for Research, Science and Technology, departmental appropriation of funds by Parliament, and commercial contracts carried out for the business enterprise sector, other government departments, and other clients.

Total intramural government sector R&D (GOVERD), by science output area, is shown in Table 10.

A number of government departments, as a product of transition to Crown Research Institutes factors, have had difficulty in completing questionnaires for the 30 June 1992 year. Data estimates have been provided after extensive consultation with the residual management groups of the respective departments.

14.2 Primary production

The major effort in government sector R&D during 1991/92 was in the area of Primary production, namely Output Classes 1 to 10. Half of the total government research carried out was in this area, and in absolute terms it received nine times more funding from the government sector than it did from the business enterprise sector ($153 million and $17 million, respectively).

Of the 10 component output classes, eight are devoted to agriculture, with the remaining two devoted to forestry and fishing.

Output Class 7 (New and Improved Horticultural Crops, Including Vegetables, and Management Practices) and Output Class 10 (New and Improved Fish Harvesting and Production Systems for Marine and Freshwater Fisheries) each accounted for about one-fifth of the primary production R&D carried out by the government sector (19 percent and 21 percent, respectively). They were followed by R&D related to forage plants (15 percent), and sheep (10 percent).

Table 10. Government sector intramural R&D, 1991/92

Output areas	Govern-ment ($000)	Group			Business ($000)	Group		
		Total	%	% of Group		Total	%	% of Group
Primary production								
01 Sheep (meat)	3,334			2	2,575			15
01 Sheep (wool)	3,652			2	1,173			7
01 Sheep (general)	15,214			10	602			4
02 Beef Production	1,211			1	206			1
03 Dairy Production	3,800			2	1,635			10
04 Alternative Animal Species	7,861			5	478			3
05 Generic Animal Research	12,000			8	204			1
06 Forage Plants	22,310			15	2,852			17
07 Horticulture	28,626			19	2,339			14
08 Arable Crops & other Plants	11,551			8	1,676			10
09 Plantation Forestry	10,605			7	2,572			15
10 Fisheries	32,742	152,906	48	21	486	16,798	8	3
Primary products and processing								
11 Meat Processing	349			2	13,995			20
12 Dairy Processing	65			0	28,550			40
13 Other Food Processing	9,407			54	10,115			14
14 Fibre, Textiles & Skin Processing	285			2	12,558			18
15 Wood & Paper Processing	7,168	17,274	5	41	6,132	71,340	35	9
Materials, engineering								
16 Materials & Industrial Processing	19,042			62	14,157			26
17 Engineering	3,672			12	23,440			42
18 Electronic & Instruments	8,044	30,758	10	26	17,894	55,491	27	32
Infrastructure								
19 Construction	650			13	7,099			17
20 Commercial & Trade	11			0	4,561			11
21 Energy	192			4	5,430			13
22 Transport Services	2,513			49	2,860			7
23 Information & Communication	1,370			27	20,577			50
24 Urban & Rural Planning	405	5,140	2	8	383	40,909	20	1
Social sciences								
25 History, Society & Culture	2,533			23	220			5
26 Relationships & Wellbeing	1,156			11	1,028			25
27 Political & Economic Relationships	4,272			39	2,140			52
28 Education, Knowledge & Training	2,873	10,834	3	27	691	4,079	2	17
Environment								
29 Environment Protection	8,282			11	1,778			47
30 Geological Structures & Processes	17,633			24	1,244			33
31 Land use, Flora & Fauna	14,943			21	62			2
32 Marine & Fresh Waters	19,924			28	610			16
33 Climate & Atmosphere	5,352			7	27			1
34 Space	330			0	0			0
35 Antarctica	5,638	72,102	23	8	52	3,753	2	1
Miscellaneous								
36 Fundamental Knowledge	10,297			44	106			1
37 Health	6,723		8	29	10,855			93
38 Defence	6,349	23,369		27	734	11,695	6	6
39 S&T Education	0			100	0	0		0
40 S&T Services	4,837		2	0	0	0	0	0
Other	0	4,837		0	14	14		
TOTAL	317,220	317,220	100		204,090	204,090	100	

The distribution of government sector R&D effort was in marked contrast with that in the business enterprise sector. Apart from the nine-fold difference in absolute funds spent, the distribution of funding was different. In particular, dairy production was only a minor field of interest in government sector R&D, but it was second only to sheep production in the business enterprise sector's R&D.

14.3 Primary products and processing

R&D in the area of Primary products and processing (Output Classes 11 to 15) was a relatively minor component of government sector R&D (5 percent) although it comprised about one-third of the business enterprise sector's R&D. The total effort in the government sector's R&D in this area was $17 million, which is about one-quarter of the R&D carried out in the business enterprise sector ($71.3 million).

Virtually all the government sector R&D in primary products and processing was concentrated in Output Classes 13 (New and Improved Fruit, Crops and Other Food and Beverage Processes, Storage Techniques and Products) and 15 (New and Improved Wood and Paper Processes and Products). These comprised 54 and 41 percent of the R&D effort, respectively. These two output classes together comprised less than a quarter (23 percent) of the business enterprise sector's R&D.

Output Class 12 (New and Improved Dairy Processes, Storage Techniques and Products) received only 0.4 percent of the government sector's R&D effort ($65,000). However, it was the most heavily funded component ($28.5 million) of the business enterprise sector's R&D, comprising 40 percent of the total effort in the processing areas.

14.4 Materials, engineering, computing and communications

Although R&D in the area of Materials, engineering and telecommunication (Output Classes 16 to 18) accounted for 27 percent of the expenditure in the business enterprise sector ($55.4 million) it was of less importance in the government sector ($31 million, 10 percent of total funding).

Output Class 18 (New and Improved Computing and Electronic, Communication and Instrumentation Processes, Systems and Products, i.e. computer hardware) was the fourth most heavily funded class in the business enterprise sector ($18 million). In the government sector it was funded only to the extent of $8 million. However, it must be borne in mind that Output Class 18 describes only directly funded R&D in this field, whereas related research is also funded indirectly by government in many other output areas. This is because information technology (IT) is becoming such a basic tool that it is becoming harder to distinguish whether research is primarily IT-related or whether it is related to some application of IT. Taking a broader definition of IT-related research would probably result in a large addition to the government sector's expenditure.

Similar arguments apply to Output Class 23 (New and Improved Information Processing Software, Software and Services for Electronic Communication, Media Transmission and Data Exchange). If the two output classes (18 and 23) are taken together it is clear that computing systems are by far the largest area of business enterprise sector R&D in New Zealand, with a total expenditure of $38 million, or just more than a fifth of all the business enterprise sector's R&D. The comparable value for government sector R&D in these two output classes is only about $9 million, or less than 3 percent of government sector R&D.

In the government sector, Output Class 16 (New and Improved Materials, Industrial Processes and Products) received the majority of the R&D funding within this group (about 62 percent). Output

Class 17 (New and Improved Engineering Processes, Systems, and Production) received 12 percent and Output Class 18 received about one-quarter (26 percent) of the funding within this group.

By contrast, Output Classes 16, 17 and 18 each received about one-third of the business enterprise sector's funding R&D for this group (26 percent, 42 percent and 32 percent, respectively).

14.5 Infrastructure and services

Infrastructure and services (Output Classes 19 to 24) was better funded in the business enterprise sector than in the government sector, with 20 and 2 percent of funding, respectively. However, this category includes Output Class 23 - see section 14.5.

The major effort in government R&D in this area was in Output Class 22 (New and Improved Information Bases, Processes and Systems for Transport), which comprised 49 percent of the total effort in this group.

14.6 Social Sciences

Expenditure on research in the social sciences in the government sector was nearly $11 million, 3 percent of the total. The business enterprise sector's expenditure in this area was $4 million, 2 percent of the total. Output Class 27 (Information Bases on Political, Economic and International Relationships) received the most attention in both sectors.

14.7 Environment, exploration and assessment of the Earth

About a quarter (23 percent) of the R&D funding in the government sector was in the area of Environment, exploration and assessment of the Earth, i.e. in Output Classes 29 to 35. By contrast, this kind of research comprised only 2 percent of the R&D of the business enterprise sector (equivalent to 5.2 percent of government funding).

As seen in Table 10, Output Classes 30, 31 and 32, which deal with Geological structures, Land use, flora and fauna, and Marine and fresh waters, respectively, received about equal funding and together comprised over two-thirds of the government expenditure in this group (73 percent). Output Class 29, which deals with R&D in the field of environmental protection, was the next most important (11 percent).

15 Source of funds for government intramural R&D, and R&D funded extramurally

In the survey, government organisations were asked to provide information on the source(s) of the funds for the R&D they undertook. The results are summarised in Table 11.

The bulk of funding (69 percent) came from the Foundation for Research, Science and Technology, which allocates funds through the contestable science funding system.

A further 20 percent of funding came from "own funds", and 5.7 percent from private sector enterprises, for research undertaken on contract.

Compare this with results from the business enterprise sector (Table 4): 68 percent of business R&D funds came from own funds (20 percent in the government sector); 7.3 percent from central and local government (74 percent in the government sector).

Table 11. Source of funds for intramural government sector R&D, 1991/92

Source of Funds	($000)	Percent
Own Funds	63,150	19.9
Foundation of Research Science and Technology	218,248	68.8
Other NZ Central Government Agency	11,656	3.7
NZ Local Government	3,313	1.0
Private Sector NZ Enterprises	18,249	5.7
Funds from Abroad	1,288	0.4
Other Sources of Funds	1,316	0.4
TOTAL	317,220	100

With provider information from the three sector surveys, it is possible to evaluate the total amount of government spending on R&D in the three sectors. The commercial research done by the government and higher education sectors can be added to the "own funds" R&D described in the business enterprise survey. This gives the full contribution to R&D of the business enterprise sector in New Zealand (refer to Tables 6 and 15).

Government agencies funded R&D carried out by other organisations in the government, business and university sectors, as shown in Table 12. By far the majority of extramural R&D research (84 percent) was carried out by central government agencies, including CRIs.

Table 12. Extramural R&D funded by the government sector, 1991/92

R&D Provider	($000)	Percent
Other NZ Central Government Agency	231,424	84
NZ Local Government Organisations	1,364	1
NZ Tertiary Education Sector	20,983	8
Private Sector New Zealand Enterprises	20,384	7
Overseas Organisations	422	0
TOTAL	274,577	100

UNIVERSITIES

16 Intramural higher education sector R&D

16.1 Introduction

The university sector carries out research as part of its mandate with Vote: Education funds, and receives funds for contract research from the Health Research Council and other Crown and private sources.

Over the last few years, a number of projects have been undertaken to gather better information on R&D expenditure in the higher education sector. Two publications, in particular, have analysed this information. The first of these, *A profile of Crown-funded R&D in New Zealand, 1991/92*[3], provides information for 1991 on all current university research projects, including full-time equivalent (FTE) personnel engaged.

The next major publication, the Bollard review[4], estimated resources used nationally for research in the non-medical university sector. It concentrated on costing that part of university research comprising public good science outputs, i.e. outside of teaching, which was funded by Vote: Education.

16.2 The review methodology

The Bollard review separated research into "teaching" and "non-teaching" research. Teaching research involved the supervision of graduate students' research and personal scholarship, where the primary objective is not directly a published paper. Non-teaching research included research performed by staff and students as part of the staff employment contract with the university, and research performed under contract for an outside party, and research that could be considered to give rise to a public good science output.

University departments estimated how much time academic staff spent in each of the four categories: graduate student supervision, scholarship, own research, and discretionary research, together with an estimate of the proportion in each category funded by Vote: Education, by other Crown funds and by non-Crown funds. The results varied by department and university. On average, however, the total time spent on all categories of research was a third of academic staff time.

Whereas academic staff time was weighted according to each departmental estimate, other staff time was weighted as follows:

	Portion of year spent on research
Honours students	0.1
Masters students	0.25
Doctoral students	0.5
Post-doctoral fellows	1.0
Research technicians	1.0
Teaching technicians	0.25

Academic and teaching technician time was divided between projects where more than one project was involved. Average salaries for each staff category were applied to the weighted full-time equivalents to obtain the salary cost. A multiplier of 2.3 was applied to academic and post-doctoral

staff salaries to reflect all direct and indirect non-salary costs of research to the university, in line with current university practice for contract research[4].

Full cost = Salary costs + non-salary costs
= 2.3 Average salary x FTE

Indirect costs for technicians and research officers were included in the academic multiplier. The multiplier included indirect costs (overheads, general expenses and departmental grants), payroll costs and depreciation, but did not include funds received from outside organisations for research and equipment.

To bring the review data into line with OECD recommendations:

- Only personal scholarship carried out specifically for a research project should be considered an R&D activity;
- Administrative and support staff providing direct project linked administration or clerical services within the R&D unit should be included in the count of FTE personnel;
- An allowance for the stipends of post-graduate research students should be included in R&D personnel costs;
- Research and equipment grants from external sources should be included; and
- Overseas funds for research should be included.

Personal scholarship comprised, on average, 23 percent of academic staff research time, but an estimate of the proportion of this time which is not related to a research project is not available.

Support staff FTE was not collected for the review, but their cost was included in the overhead multiplier.

The payments on behalf of the Crown to universities for post-graduate scholarships ($6.9 million) and research equipment ($4.8 million) have been added to the Bollard review estimates. Overseas funding for research is not available, but its omission may compensate for the overestimate related to scholarships noted above.

The results of the review are presented separately for medical schools and all other departments, by source of funds, in Table 13. Note: The information in Tables 13 and 14 are the same as last year, as no updated information is available.

16.3 Additional information from Universities' annual reports, and from funders of R&D

Information on the amount of research funds received by universities from external sources was collated from universities' annual reports, and from registry offices. This indicates that for 1991, the year for which benchmark data were collected, total external funding amounted to $70.4 million, of which $16.3 million was from the Health Research Council.

Data from the 1990/91 private sector and government sector R&D surveys indicate that these sources provided only $7.7 million and $21.3 million for university research, respectively. There are several possible reasons for these wide variations. The estimates by the universities may be high because they include work carried out for the private sector which involves consulting, or the application of existing knowledge, rather than research. Examples include testing equipment or survey design. As discussed in the government section, only one third of the DSIR's external contracts were considered

Table 13. University expenditure on R&D, 1991, based on the Bollard review

Funding Source	Medical Schools	All other Departments	Total ($ million)
Non-Crown	1.8	2.9	4.7
Vote: Education	9.6	74.0	83.6
Other Crown	2.7	4.3	7.0
TOTAL	14.1	81.2	95.3

to involve R&D. If the ratio of R&D to consulting and services is similar for the universities, then one would expect external funds for R&D to be one-third of $70 million, or around $23 million. Data from R&D funders in the government and business enterprise R&D surveys indicated that these two sectors funded $29 million of university R&D, whereas the Bollard review result suggested that external funding only amounted to $11.7 million. The Bollard review result is likely to be an underestimate because external funds were not included in the estimation of costs. Another factor is that the review did not attempt to cover all privately funded work, since the focus was public good research.

The R&D survey figures may underestimate the true cost of the research, since some university contracts cover only their marginal costs. For the purposes of these estimates, the business and government sector R&D survey funders' data will be taken as the best available estimates of university R&D funded by these sources.

The Bollard review[4] noted that Health Research Council R&D tended to be coded inconsistently by university respondents, with many coding the source of funds as own research (funded by Vote: Education) instead of discretionary research funded by the Crown. An adjustment has been made by redistributing $5 million of the medical research costs from Vote: Education back to "the Crown" as source, leaving $4.6 million funded by Vote: Education, or General University Funds (GUF) in OECD terminology.

The final estimates for university research funding by source is shown in Table 14.

Table 14. Adjusted estimates of University R&D expenditure 1991

Funding Source	Medical Schools	Other Departments	Total ($ million)
Business enterprises	3.7	4.8	8.5
Government sector	16.4	4.9	21.3
General university funds			
Block grant (review estimates)	4.6	74.0	78.6
Post-graduate scholarships	1.5	3.3	4.8
Equipment grant	1.7	5.2	6.9
TOTAL	27.9	92.1	120.1

ALL SECTORS

When the three sectors of R&D provider data are added together, the result is an estimate of the total R&D carried out in New Zealand.

17 Source of R&D funds, sector of performance and output class, from provider data

Data from R&D providers in each sectoral survey is summarised in Table 15. Each column represents the total R&D provided by that sector. Reading across the rows it is possible to estimate the total R&D funded by each sector. This will differ from the estimates obtained by using each sector's provider and funder data in isolation, as was done, for example, to obtain the estimates in Table 6.

Table 15. Gross expenditure on R&D carried out in or funded by NZ, 1991/92

Source of funds	Sector of performance ($ 000)					Done in NZ or funded by NZ
	Done by Business	Done by Government	Done by University	Total Done in NZ	Done Overseas	
Business	180,184	19,547	8,770	208,502	18,169	226,670
FRST	10,846	218,248		229,096		229,096
Other Govt Contracts	4,005	78,119	20,980	103,105	422	103,527
University Block grant			90,300	90,300		90,300
Sub-total Govt	14,851	296,367	111,280	422,501	422	422,923
University (own funds)	65	18		82		128
Overseas Funds	8,984	1,288		10,272		10,272
TOTAL	204,090	317,220	120,050	641,360	18,590	659,950

Totals rounded to nearest 10,000

Thus, from this table it is estimated that the business enterprise sector spent $227 million on R&D the government sector spent $333 million, and the universities spent $90 million. Of the total of $660 million, $18.5 million was spent overseas, and overseas funds paid for $10 million of the R&D carried out in New Zealand.

Total intramural R&D, by output class, is summarised in Table 16.

Table 16. Intramural R&D, all sectors, by output class, 1991/92

Output Class	Business ($000)	Government ($000)	Universities* ($000)	TOTAL ($000)
01 Sheep (meat)	2,575	3,334	1000	6,909
01 Sheep (wool)	1,173	3,652	n.a.	4,825
01 Sheep (general)	602	15,214	n.a.	15,816
02 Beef Production	206	1,211	90	1,507
03 Dairy Production	1,635	3,800	300	5,735
04 Alternative Animal Species	478	7,861	800	9,139
05 Generic Animal Research	n.p.	12,000	3,300	15,504
06 Forage Plants	2,852	22,309	2,500	27,661
07 Horticulture	2,339	28,625	2,900	33,864
08 Arable Crops & other Plants	1,676	11,550	2,500	15,726
09 Plantation Forestry	2,572	10,605	1000	14,177
10 Fisheries	486	32,742	1000	34,228
11 Meat Processing	13,995	349	400	14,744
12 Dairy Processing	28,550	65	900	29,515
13 Other Food Processing	10,115	9,407	1,100	20,622
14 Fibre, Textiles & Skin Processing	12,558	285	500	13,343
15 Wood & Paper Processing	6,132	7,168	500	13,800
16 Materials & Industrial Processing	14,157	19,042	4,900	38,099
17 Engineering	23,440	3,672	2,400	29,512
18 Electronic & Instruments	17,894	8,044	2,500	28,438
19 Construction	7,099	650	2,600	10,349
20 Commercial & Trade	4,561	11	400	4,972
21 Energy	5,429	192	2,700	8,321
22 Transport Services	2,860	2,513	600	5,973
23 Information & Communication	20,577	1,370	4,700	26,647
24 Urban & Rural Planning	383	404	500	1,287
25 History, Society & Culture	220	2,533	1,700	4,453
26 Relationships & Wellbeing	1,028	1,156	2,300	4,484
27 Political & Economic Relationships	2,140	4,271	3,400	9,811
28 Education, Knowledge & Training	691	2,873	3,200	6,764
29 Environmental Protection	1,778	8,282	7,900	17,960
30 Geological Structures & Processes	1,224	17,633	6,400	25,257
31 Land use, Flora & Fauna	62	14,943	3,800	18,805
32 Marine & Fresh Waters	610	19,924	5,300	25,834
33 Climate & Atmosphere	27	5,352	2,000	7,379
34 Space	0	330	1,400	1,730
35 Antarctica	52	5,638	800	6,490
36 Fundamental Knowledge	106	10,297	13,750	24,153
37 Health	10,855	6,722	27,600	45,177
38 Defence	734	6,349	0	7,083
39 S&T Education	14	0	100	114
40 S&T Services	0	4,837	0	4,837
TOTAL	204,090	317,220	120,050	641,360

* University data are estimates for 1991.

n.p. = Not published for reasons for confidentiality

18 Type of expenditure, business and government sectors

Government agencies were asked to indicate how they spent their funds on R&D. The results are contrasted with those from business enterprise in Table 17.

Wages and salaries consumed 47 percent of the $317 million allocated to R&D in the government sector, compared with 54 percent in the business sector. Other current expenditure accounted for 40 percent in the government sector and 37 percent in business. Capital expenditure was 13 percent, compared with 9 percent in the business sector.

Table 17. Type of R&D expenditure, business and government sectors, 1991/92

Type of Expenditure	Sector			
	Government ($ million)	Percent	Business ($ million)	Percent
Wages & Salaries	149.1	47	110.1	54
Current	127.1	40	75.5	37
Capital	41.0	13	18.5	9
TOTAL	317.2	100	204.1	100

PERSONNEL

19 R&D personnel

19.1 Occupations

Business enterprises and government agencies were asked to provide information on the total number of R&D personnel, as well as breakdowns by gender and occupation. The university review obtained similar data by occupational group, but not by gender. Figures were provided in full-time equivalent (FTE) staff numbers, and are given in Table 18.

Government figures are subject to problems of reclassification. One major agency reclassified senior technicians as researchers because of their involvement in the preparation of bids for contestable funding, and also reclassified field officers from support staff to technicians. With the subsequent restructuring it has not been possible to obtain the exact figures, but an indicative correction is shown in the final column of Table 18.

Table 18. Full-time equivalent personnel engaged in R&D, all sectors, by occupation, 1991/92

Occupation	Gender	Business enter-prise	Research Assns, Producer Boards	CRI's + Govt Depts	Total (Bus + Govt) •	Univer-sities	Total all sectors •
Researchers	M	972	250	1297	2519	n.a.	
	F	155	58	221	434	n.a.	
	Total	1127	308	1518	2953	1872	4825
Technicians	M	467	167	988	1622	n.a.	
	F	140	108	511	759	n.a.	
	Total	607	275	1499	2381	454	2835
Support staff	M	93	57	438	588	n.a.	
	F	107	81	400	588	n.a.	
	Total	200	138	838	1176	n.a.	1177
All FTE	M	1532	474	2723	4729	n.a.	
	F	402	247	1132	1781	n.a.	
	Total	1934	721	3855	6510	*2326	8836

• Gender sub-totals do not include university FTE

* University FTE in R&D:
460 academic staff
242 research officers
171 post-doctoral fellows
86 teaching technicians
386 research technicians
450 Masters students (at 25 percent)
549 PhD students (at 50 percent)

Government figures, including personnel engaged in research and consulting and services, are shown in the shaded column. These data are indicative only, and include only science agencies.

The total number of personnel employed in R&D came to 8,836 FTE. Excluding universities, 4,729 (73 percent) were male and 1,781 (27 percent) were female.

Women make up 21 percent of R&D staff in the business sector, 29 percent in CRIs and government departments, and 34 percent in research associations and producer boards.

Women, across all sectors, account for 15 percent of researchers, 32 percent of technicians, and 50 percent of support staff. The highest proportion of women researchers are found in research associations and producer boards (the lowest in business). The highest proportion of women technicians are found in research associations and producer boards (the lowest in business). The highest proportion of women support staff are found in research associations and producer boards (the lowest in CRIs and government departments).

Using the "all sector" figures there are 0.59 technical staff for each researcher. This may be compared to an Australian survey (1987/88) which showed this ratio at 0.47 across all sectors.

19.2 Qualifications

Business enterprises and government agencies were asked to provide information on the highest qualifications of their R&D personnel, as well as breakdowns by gender. Figures were provided in full-time equivalent (FTE) staff numbers, and are given in Table 19. University figures have been estimated from occupation data, and are only indicative. Where university figures have been included, this is specifically noted. This is the first year that research associations and producer boards have been treated separately. The information shows:

- The highest proportion of PhDs among R&D staff occurs in universities (22 percent). CRIs and government departments have (19.8 percent). The lowest proportion occurs in business (5.8 percent);

- Forty-four percent of staff in the business sectors have some kind of degree (not counting PhDs); the equivalent figure for both research associations and producer boards, and CRIs and government departments, is 32 percent. Thus, in these three groups combined, Batchelor degrees are the most common qualification among R&D staff (at 35 percent);

- People holding technical qualifications represented 16 percent of R&D personnel (ranges from 15 to 19 percent over the sectors). People holding trade qualifications represented 5 percent of R&D staff.

- R&D staff with "other post-secondary" qualifications represented 2 percent, those with "secondary" qualifications 16 percent (the highest percentage in research associations and producer boards), and "other/none" came to 10 percent.

- Women made up 8 percent of PhDs, 26 percent of Batchelors degrees, and 40 percent of those with no qualifications (while making up 27 percent of all staff).

Table 19. Full-time equivalent personnel engaged in R&D, all sectors, by qualifications, 1991/92

Qualification	Gender	Business	Research Assns + Producer Boards	CRI's + Govt Depts	Total (Business+ Govt)	Univer-sities●	Total
PhD	M	105	91	704	900	n.a.	
	F	7	14	61	82	n.a.	
	Total	112	105	765	982	516	1498
Degrees	M	696	165	838	1699	n.a.	
	F	156	67	386	609	n.a.	
	Total	852	232	1224	2308	1401	3709
Technical	M	306	91	434	831	n.a.	
	F	64	36	133	233	n.a.	
	Total	370	127	567	1064	409	1472
Trade	M	166	42	65	273	n.a.	
	F	22	10	55	87	n.a.	
	Total	188	52	120	360	n.a.	360
Other post-secondary	M	30	23	18	71	n.a.	
	F	16	14	18	48	n.a.	
	Total	46	37	36	119	n.a.	119
Secondary	M	160	57	343	560	n.a.	
	F	94	100	267	461	n.a.	
	Total	254	157	610	1021	n.a.	1021
Other/none	M	69	7	321	397	n.a.	
	F	43	4	212	259	n.a.	
	Total	112	11	533	656	n.a.	656
All FTE	M	1532	476	2723	4731	n.a.	
	F	402	245	1132	1779	n.a.	
	Total	1934	721	3855	6510	2326	8836

n.a. = data not available

● indicative estimates only

TECHNOLOGICAL BALANCE OF PAYMENTS

20 Business and Government Sectors

Government and business sector payments and receipts abroad for technical know-how are shown in Table 20. The major difference from last year is in the business sector. Last year, business paid out $2.9 million more than it received; this year, it received a nett amount of $4.8 million. Current government figures are almost identical to those of last year.

The national balance of payments for international transactions relating to trade in technical know-how for the business enterprise and government sectors was a surplus of $9.3 million.

Technical know-how includes patents, licences and technical and engineering services that increase the existing technical knowledge in a business. For a full definition refer to Section 5.

Table 20. Technological balance of payments, 1991/92

	Business sector ($000)	Government sector ($000)
Receipts	31,232	4,616
Payments	26,422	63
Balance received	4,810	4,553

ANNEX 1

Members of the advisory group to the business enterprise R&D survey

1991/92		Area of Expertise
Dr Alan Royal	NZ Meat Research & Development Council	Research needs of the Meat Industry
Mr Dennis Thomas	New Zealand Dairy Board	Dairy Research
Dr Rob Whitney	Director, Coal Research	Research Associations
Mr Cliff Gibson	Consultant, 15 Waikare St, Karori	Software Research
Ms Gisela Ahlborn	Research Manager, Fresh Fruit Exports	Horticultural Research (pipfruits)
Ms Janine Cowling	NZ Wool Board	Wool and Fibre Research
Dr Paul Atkinson	NZ Pastoral Agricultural Research Ltd	Pastoral Agricultural Research
Mr Don Killick	Client and Liaison Manager, Industrial Research Ltd	Technology Uptake and Industrial research
Mrs Linda Cooper	Group Services Controller Fisher & Paykel Ltd	Electronics and Production Machinery
Mr Guy Sanders	Statistics New Zealand	Financial Surveys Section
Ministry of Research, Science and Technology:		
Dr Margriet Theron	Chair	Research Services
Mr Mike Doig	Group Manager, Policy	Priorities and Funding
Ms Pamela Walker	Convenor	Science Resource Analysis

ANNEX 2

Government sector organisations undertaking and funding R&D

A. Government sector organisations undertaking R&D

Accident Compensation Corporation
Alcohol Advisory Council
Audit Office
Department of Conservation
Department of Health
Department of Internal Affairs
Department of Inland Revenue
Department of Justice
Department of Labour
Department of Social Welfare
Department of Scientific & Industrial Research (replaced by CRI's)
Forest Research Institute
Hillary Commission
Law Commission
MAF Marine and Freshwater Research
MAF Technology (no longer exists)
MAF Policy
Maori Language Commission
Ministry of Commerce
Ministry of Defence, Defence Scientific Establishment
Ministry for the Environment
Ministry of External Relations and Trade
Ministry of Maori Affairs (no longer exists)
Ministry of Transport
National Museum
NZ Council for Educational Research
NZ Historic Places Trust
NZ Lottery Grants Board
NZ Tourism Department
Race Relations Conciliator
Securities Commission
Waitangi Tribunal

B. Government sector organisations funding R&D

Agricultural & Marketing R&D Trust
Earthquake & War Damage Commission
Foundation of Research Science and Technology
Health Research Council
Human Rights Commission
Lottery Grants Board
Ministry of Youth Affairs
Road Traffic Safety Council
Transit NZ

ANNEX 3

Science output classes

Agriculture, horticulture, forestry and fisheries

New and improved

1 Sheep and sheep production systems
2 Beef animals and beef production systems
3 Dairy animals and dairy production systems
4 Other animal species, animal products and primary production systems
5 Generic animal and animal production information bases, systems and products
6 Forage plants and forage management practices
7 Horticultural crops (including vegetables) and management practices
8 Arable crops, ornamental, amenity, shelter, conservation and other plants and management practices
9 Trees and plantation management systems
10 Fish harvesting and production systems for marine and freshwater fisheries

Secondary industries

New and improved

11 Meat processes, storage techniques and products
12 Dairy processes, storage techniques and products
13 Fruit, crops and other food and beverage processes, storage techniques and products
14 Fibres and skin processes and products
15 Wood and paper processes and products
16 Materials, industrial processes and products (includes mineral processing)
17 Engineering processes, systems and products (including transport engineering)
18 Computing and electronic, communication and instrumentation processes, systems, and products (hardware).
19 Construction processes, systems and products (including roading construction)

Commercial and trade services

New and improved

20 Information bases, processes and systems for commercial and trade services

Energy

New and improved

21 Information bases for prospecting, production and use of all energy sources

Transport

New and improved

22 Information bases, processes and systems for transport

Information processing and communications services

New and improved

23 Information processing software, software and services for electronic communication, media transmission and data interchange.

Urban and rural planning

New and improved

24 Urban and rural planning information bases, processes and systems

Social development and services

Information bases on

25 New Zealand history, society, culture and Te Ao Maori

26 Social and personal development, relationships and wellbeing

27 Political, economic and international relationships

28 Knowledge, education and training

Environment

New and improved

29 Protection and management technologies for the environment

Exploration and assessment of the earth

Information bases on

30 Geological structures and resources, and solid earth processes (including mineral prospecting - see output 16 for mineral processing)

31 The properties, distribution, and potential uses of types of land and land based flora and flora

32 Marine and fresh waters, their substrate, flora and fauna

33 Climate and the atmosphere

34 Properties, uses and technologies for space

35 The natural environment of Antarctica

General advancement of knowledge

Information bases on

36 Fundamental information in the natural sciences, engineering, social sciences and humanities (where no end use has been identified)

Health

New and improved

37 Information bases, systems and products in health

Defence

New and improved

38 Information bases, systems and technologies for defence

S&T Education and Services

39 Further education/training of those already active in the science community.

40 Provision of scientific and technological services e.g. museums, zoological and botanical gardens; publishing and primary measurement standards.

ANNEX 4 New Zealand Standard Industrial Classification

(Grouped for the purposes of R&D statistics)

Industry Groups	Component Industries	NZSIC codes
Agriculture	Agriculture, Forestry, Fishing	11,12,13
Mining	Mining and Quarrying	2
Basic Metals	Ferrous Metals	371
	Non-ferrous Metals	372
	Fabricated Metal Products	381
Chemical Group	Chemicals (industrial and other chemicals)	351, 352 except 3522
	Drugs	3522
	Petroleum Refining	353, 354
Chemical-linked	Food, Drink and Tobacco	31
	Textiles, Footwear and Leather	32
	Rubber and Plastic Products	355, 356
Electrical Group	Electrical Machinery	383 except 3832
	Electronic Equipment and Components	3832
Machinery	Instruments	385
	Office and Computing Machinery	3825
	Machinery n.e.c.	382 except 3825
Other Manufacturing	Stone, Clay, Glass	36
	Paper and Printing	34
	Wood, Cork and Furniture	33
	Other Manufacturing	39
Transport Equipment	Motor Vehicles	3843
	Ships	3841
	Other Transport	3842,3844,3849
Infrastructure Services	Utilities (electricity, gas and water)	4
	Construction	5
	Wholesalers (industrial machinery, electrical and professional equipment) and Producer Boards	61
	Transport, Storage	71
	Communication	72
Financial, Software Services	Business and Financial Services (trading banks)	8 except 8323,8324
	Computer Bureaux and Consultancy, Software Development	8323
Engineering, scientific services	Community, Social and Personal Services including Research and Scientific Institutes, Charities, Local Authorities	9
	Engineering, Architectural and Technical Services	8324

n.e.c. = not elsewhere classified

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10. Ministry of Research, Science and Technology, 1992, "New Zealand Research and Development Statistics: All Sectors, 1990/91" Wellington. *Publication No.7.*

Other Research and Development Publications

The Ministry of Research, Science and Technology is conducting annual surveys of research and development (R&D) in the business enterprise, government and university sectors. The results of the surveys which have been undertaken are published in the following reports:

"New Zealand Research and Experimental Development Statistics: Business Enterprise Sector, 1989/90", Ministry of Research, Science and Technology, Wellington 1991. *Publication No.l.*

"New Zealand Research and Experimental Development Statistics: Government Sector, 1989/90", Ministry of Research, Science and Technology, Wellington 1992. *Publication No.3.*

"A Profile of Crown-Funded R&D in New Zealand 1991/92", Ministry of Research, Science and Technology, 1992. *Publication No.5.*

"New Zealand Research and Experimental Development Statistics", All Sectors, 1990/91, Ministry of Research, Science and Technology, Wellington, 1993. *Publication No.7.*